10/742341

Refine Search

Search Results -

Terms	Documents
L7 and temperature.clm. and (prox$ neare3 sens$)	1

Database:
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Search: L8

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Search History

DATE: Thursday, October 26, 2006 Purge Queries Printable Copy Create Case

Set Name side by side	Query	Hit Count	Set Name result set
DB=USPT; THES=ASSIGNEE; PLUR=YES; OP=OR			
L8	L7 and temperature.clm. and (prox$ neare3 sens$)	1	L8
L7	6869538.pn.	1	L7
DB=PGPB,USPT; THES=ASSIGNEE; PLUR=YES; OP=OR			
L6	L5 and 219/509.ccls.	1	L6
L5	(single adj house) and heat$.clm. and temperature.clm. and (prox$ neare3 sens$)	6	L5
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L4	(single adj house) and heat$.clm. and temperature.clm.	2	L4
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L3	(single adj house) and "heat-pump".clm. and temperature.clm.	0	L3
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L2	trane and "heat-pump".clm. and temperature.clm.	0	L2
DB=PGPB,USPT; THES=ASSIGNEE; PLUR=YES; OP=OR			

L1	trane and heatpump.clm. and temperature.clm.	0	L1

END OF SEARCH HISTORY

L8: Entry 1 of 1 File: USPT Mar 22, 2005

DOCUMENT-IDENTIFIER: US 6869538 B2
TITLE: Method and apparatus for controlling a medical fluid heater

Brief Summary Text (24):
The tip protector used to house the patient fluid connector includes a hydrophobic filter that allows air but not fluid to escape. This vented tip protector enables the system to be primed without having to perform elevation balancing or controlled fluid metering. The system performs a prime by flowing fluid through the system and into the patient fluid line until the dialysate backs up against the filter, causing a fluid pressure increase, which is sensed by the system. The system then stops the pump.

Brief Summary Text (25):
The hardware unit also provides a controller. The controller includes a plurality of processors, a memory device for each processor and input/output capability. One of the processors coordinates operation of the pump actuator, the valve actuator and the heater with the various stages of dialysate flow, such as the fill, dwell and drain stages. The processor also controls or obtains feedback from a plurality of different types of sensors. The sensors include, among others, a capacitance fluid volume sensor, a dialysis fluid temperature sensor, a pressure sensor, a vacuum sensor, an air detection sensor and a mechanical positioning sensor.

Brief Summary Text (27):
The capacitance fluid volume sensor indicates a volume of fluid in the pump chamber, wherein the sensor generates a voltage signal that is indicative of the volume of fluid in the receptacle. The controller receives the voltage signal and converts the signal into an amount of fluid or an amount of air within the flexible fluid receptacle of the pump chamber.

Brief Summary Text (28):
The pump actuator can be mechanically or pneumatically operated. When mechanically driven, a pump motor drives a vacuum source, such as a piston-cylinder, which pulls a vacuum on the membranes of the fluid receptacle of the disposable unit. Here, a mechanical positioning sensor, such as an encoder, senses the angle of a pump motor shaft relative to a home position and sends a signal to the controller, wherein the controller can adjust the pump motor accordingly. The encoder also provides safety feedback to the controller, whereby the controller, once therapy starts, prevents the camshaft from rotating to a position where the valves can free fill the patient. When the pump actuator is pneumatically operated, the system in an embodiment uses a vacuum pump to pull apart the membranes of the fluid receptacle. Here, the system uses a vacuum sensor to sense the state of the vacuum pump and a mechanical sensing device, such as a linear encoder, to sense the state of a pump piston.

Brief Summary Text (31):
The system employs a method of heat control that uses a knowledge-based algorithm and a fuzzy logic based algorithm. The former uses laws of physics, empirical data and sensed inputted signals. The latter inputs a difference between desired and

actual temperatures and uses fuzzy logic membership functions and fizzy logic rules. Each algorithm operates at a different update frequency. Each algorithm outputs a duty cycle, wherein the system weights the fuzzy logic based duty cycle relative to the knowledge based duty cycle and produces an overall heater control duty cycle. This method enables accurate dialysate temperature control.

Brief Summary Text (32):
The system automatically purges air from the dialysate, for example, through the pump chamber. The system also senses a total volume of fluid pumped to the patient, records and logs same. Furthermore, the system knows the instantaneous flow rate and fluid pressure of fluid entering or leaving the patient's peritoneal cavity.

Brief Summary Text (33):
The disposable unit includes a valve manifold. The manifold defines a plurality of valve chambers. The hardware unit includes a valve actuator that selectively and sequentially presses against one or more of the valve chambers. In an embodiment, a mechanically operated valve actuator includes a single camshaft and a plurality of cams. The cams press against one of the membranes of the disposable unit to engage the other membrane and block or disallow fluid flow. As stated above, the system uses a sensing device, such as a rotary encoder, to sense the angle of the camshaft relative to a home position, so that the controller can rotate the camshaft to open or close one or more valves as desired. The single camshaft toggles back and forth between: supply and pump chamber fill positions; patient drain and system drain positions; and between pump chamber fill and patient fill positions. These positions are actuated by a unique rotational position on an overall cam profile (i.e., the superposition of each of the individual cams as seen from the end of the camshaft).

Drawing Description Text (19):
FIGS. 17A and 17B illustrate an embodiment of a mechanically operated fluid pump and capacitance type fluid volume sensor of the present invention.

Drawing Description Text (20):
FIG. 18 illustrates an alternate embodiment of a fluidly operated fluid pump and capacitance sensor of the present invention.

Detailed Description Text (7):
The controller 30 includes a plurality of processors and a memory device for each processor. The processors include a main microprocessor and a number of delegate processors. The main microprocessor runs certain higher level tasks such as the graphical user interface ("GUI") described below. The delegate processors perform lower level tasks, such as moving valves, reading sensors, controlling heater duty cycle, etc. An additional processor is provided solely for the purpose of tracking safety parameters, such as heater plate and medical fluid temperature. For purposes of the present invention, except where otherwise specified, the term "processor 34" refers collectively to all of the processors and the term "memory device 32" refers collectively to all of the corresponding memory devices.

Detailed Description Text (8):
The controller 30 also includes an input/output ("I/O") module 36. The memory device 32 stores a computer program that contains a step by step sequence for the system 10 and configures certain outputs to occur upon specified inputs. The processor 34 runs the program in the memory device 32. The I/O module 36 accepts signal lines from various sensors. The I/O module 36 also connects to power lines including input power lines (including if battery powered) and power lines outputted to the various electrical components.

Detailed Description Text (15):
The system 10 provides a fluid volume sensor 60, which measures the actual volume of medical fluid that has been forced through the pump 20. By summing multiple

individual pump volumes, the controller accurately knows how much medical fluid or dialysate has been delivered to the patient 12. The system 10 in an embodiment repeats the pump fill phase and the heater fill phase until the pump 20 has delivered a predetermined volume of medical fluid. The predetermined volume can be inputted into the controller 30 by a patient or operator via the touch screen 42.

Detailed Description Text (19):
One embodiment of the fluid volume sensor 60 is described in more detail below in connection with the description of the diaphragm pump 20. Besides the fluid volume sensor 60, the system 10 includes various other desired types of sensors.

Detailed Description Text (20):
The system 10 includes temperature sensors 62, such as the sensors T1 to T4, which measure the temperature at relevant places within the system 10. In an embodiment, the sensors 62 are non-invasive, however, any other types of temperature sensors may be employed. As illustrated in FIG. 1, sensors T1 and T2 provide redundant post heater feedback of the fluid temperature to the controller 30. Sensor T3 provides a temperature of the medical fluid prior to heating. Sensor T4 provides the ambient temperature.

Detailed Description Text (21):
The system 10 also provides temperature sensors 62 that monitor the temperature of the heater 16. In an embodiment, the heater 16 is an in-line plate heater. The in-line plate heater 16 can have one or more heater plates, for example, two heater plates having a disposable unit placed between same. Separate temperature sensors PT1 and PT2 are provided to monitor the temperature of each of the plates of the plate heater. The system 10 can thereby control each plate heater individually.

Detailed Description Text (22):
The system 10 includes one or more air sensors 64, such as the sensor AS1, placed directly at the throat of the inlet and outlet of the pump 20. Another air sensor AS2 monitors air in the medical fluid after it leaves the heater 16 and just before the final shut-off valve V3 leading to the catheter line 56. The controller 30 monitors the air content sensed by the air sensors 64 and thereby controls the system 10 to perform any necessary air purge. The system 10 can separate and discharge the air from the fluid or simply convey the air to the drain 18. The system 10 also includes an air vent solenoid 66, which is operated by the controller 30. The air vent solenoid 66 enables the system 10 to relieve the vacuum applied to one or both of the membranes in the pump 20.

Detailed Description Text (24):
The system 10 provides various fluid pressure sensors 68. Fluid pressure sensors FP1 and FP2 provide a redundant pressure reading of the fluid in the fill line 52 leading to the pump 60. The fluid pressure sensors 68 provide a signal to the controller 30 that indicates the respective fluid pressure at that location. Based on the signals from the pressure sensors FP1 and FP2, the controller 30 operates the fluid pumps and valves to obtain and maintain a desired fluid pressure. As stated above, the system 10 maintains the pump pressure, for example, at about three psi.

Detailed Description Text (25):
The system 10 also provides various valve pressure sensors 70. Valve pressure sensors VP1 to VP5 detect the fluid pressure at the valves V1 to V5. The system 10 further provides one or more vacuum pressure sensors 72, for example, at the vacuum source 44, to ensure that a proper vacuum is maintained on the membrane receptacle within the pump 20.

Detailed Description Text (26):
In an embodiment, the fluid pressure, valve pressure and vacuum sensors 68, 70 and 72, respectively, are non-invasive sensors. That is, the sensors do not physically

contact (and possibly contaminate) the medical fluid or dialysate. Of course, the system 10 can include other flow and pressure devices, such as flow rate sensors, pressure gauges, flowmeters, or pressure regulators in any suitable quantity and at any desired location.

Detailed Description Text (27):
The system 10 also includes various positioning sensors. In an embodiment, the positioning sensors include a linear encoder 74 that monitors the position of the linear pump actuator 24 and a rotary encoder 76 that monitors the angular position of the valve actuator 26 or camshaft. An encoder is one type of positioning feedback device that can be employed. Other types of positioning feedback systems include proximity sensors and magnetic pick-ups that sense a pulse, e.g., a gear tooth of a gear attached to the camshaft, and output the pulse to a counter or microprocessor.

Detailed Description Text (29):
In an embodiment, the encoders 74 and 76 are absolute type encoders that know the location of the home position 78 even after a power loss. In another embodiment, the encoders 74 and 76 are incremental encoders and a battery back-up is provided to the controller so that the system 10 can maintain the location of the home position 78 even when no external power is applied. Further alternatively, system 10 can be programmed to automatically move the pump actuator 24 and the valve actuator 26 upon power-up until a home position is sensed, wherein the system 10 can begin to run the main sequence.

Detailed Description Text (41):
The hardware unit 110 contains the pump 20 or 120 and the linear pump actuator 24 if system 10 is employed. The hardware unit 110 also contains the valve actuator 26 including the valve motor 28, the in-line heater 16, the various sensors, the vacuum source 44 including the air pump motor 46 and the controller 30 as well as the other hardware described above. FIG. 4B illustrates that one of the pump chamber walls of the pump 20 or 120 is disposed in the lid 116 of the housing. In FIG. 4B, the heater 16 is disposed in the base 114 of the housing 112. Alternatively or additionally, the heater may be placed in the lid 116. The base 114 also contains the opposing pump chamber wall.

Detailed Description Text (86):
When the peritoneal fluid reaches the patient fluid connector 290, most all the air within the system 10 has been pushed through the hydrophobic membrane 300 attached at the end of the tip protector 280 housed in the one-piece tip protector 270. The nature of the hydrophobic membrane 300 is that it allows air to pass through but filters or does not allow water or peritoneal fluid to pass through same. Thus, when the fluid finally reaches the hydrophobic membrane 300, the lack of any additional space in which to flow fluid causes the pressure to increase within the system 10, 100. The system 10, 100 provides one or more pressure sensors, for example pressure sensors 68 (marked as FP1, FP2 and FPT in FIGS. 1 and 2).

Detailed Description Text (87):
One or more of the pressure sensors 68 sense the increase in pressure due to the peritoneal fluid backing up against the hydrophobic filter 300. The pressure sensor (s) sends a signal to the I/O module 36 of the controller 30. The controller 30 receives the signal and is programmed in memory device 32 to shut down the diaphragm pump 20, 120. In this manner, the system 10 self-primes each of the fill lines 287 and 289, the disposable unit 160 and the patient fluid line 292 automatically and without need for controlled volume calculations or gravity feeding.

Detailed Description Text (88):
System 10, 100 also includes one or more safety features that may be based upon a volume calculation. That is, under normal operations, the system 10, 100 does not

control the priming using a volume calculation. However, in the case where for example the patient removes the patient fluid connector 290 from the vented tip protector 280 of the one-piece tip organizer 270 before the system 10, 100 senses a pressure increase and stops the pumps 10, 100, the system 10, 100 can employ an alarm calculation, wherein the system 10, 100 knows that it has pumped too much peritoneal fluid (e.g., a predetermined amount more than the internal volume of the system) and shuts down pump 20, 120 accordingly.

Detailed Description Text (130):
When the patient closes lid 116, a second mechanical interlock (not illustrated) locks the lid in place, so that the patient cannot open the lid 116 during therapy. The system 10, 100 senses when the patient has removed the patient fluid line 292 and connector 290 from the transfer set, which is implanted in the patient 12. Only then will the system 10, 100 allow the patient to open the lid 116. The mechanical interlocks prevent free-filling, overfilling and the patient from tampering with the system while it is running. The valve configuration provides a fail safe system that prevents fluid flow in the event of a failure or power down.

Detailed Description Text (153):
B. Capacitance Volume Sensor

Detailed Description Text (154):
FIGS. 17A and 17B also illustrate that the pump 20 cooperates with an embodiment of the capacitance fluid volume sensor 60 of the system 10. One embodiment of a capacitance sensor 60 is disclosed in greater detail in the patent application entitled, "Capacitance Fluid Volume Measurement," Ser. No. 10/054,487, filed on Jan. 22, 2002, incorporated herein by reference. The capacitance sensor 60 uses capacitance measurement techniques to determine the volume of a fluid inside of a chamber. As the volume of the fluid changes, a sensed voltage that is proportional to the change in capacitance changes. Therefore, the sensor 60 can determine whether the chamber is, for example, empty, an eighth full, quarter full, half full, full, or any other percent full. Each of these measurements can be made accurately, for example, at least on the order of the accuracy achieved by known gravimetric scales or pressure/volume measurements. The present invention, however, is simpler, non-invasive, inexpensive and does not require the medical operation to be a batch operation.

Detailed Description Text (157):
As the membranes 162 and 164 expand and fill with medical fluid, the overall capacitance changes, i.e., increases. The sensor 60 generates a high impedance potential across the grounded and active capacitor plates 224 and 226. The high impedance potential is indicative of an amount of fluid in the receptacle 172. If the potential does not change over time when it is expected to change, the sensor 60 can also indicate an amount or portion of air within the receptacle 172.

Detailed Description Text (158):
A capacitance sensing circuit amplifies the high impedance signal to produce a low impedance potential. The low impedance potential is also fed back to the guard plate 228, which protects the sensitive signal from being effected by outside electrical influences. The amplified potential is converted to a digital signal and fed to the processor 34, where it is filtered and/or summed. The video monitor 40 can then be used to visually provide a volume and/or a flowrate indication to a patient or operator. Additionally, the processor 34 can use the summed outputs to control the pump 20 of the system 10, for example, to terminate dialysate flow upon reaching predetermined overall volume.

Detailed Description Text (159):
Referring now to FIG. 18, the pump 120 of the system 100 is illustrated in operation with the capacitance sensor 60 of the present invention. The pump 120 forms a clamshell with first and second portions 246 and 248, which together form

the pump chamber 250. The portions 246 and 248 are rigid, fixed volume, disked shaped indentations in the base 114 and lid 116 of the hardware unit 110. The clamshell first and second portions 246 and 248 are closed and sealed on the pump receptacle portion 172 of the disposable unit 110, which includes the expandable membranes 162 and 164.

Detailed Description Text (166):
The clamshell portions 246 and 248 form and hold the capacitor plates of the capacitance sensor 60. In an embodiment, upper clamshell portion 246 includes an active metal or otherwise conductive capacitance plate 258 between electrically insulative or plastic layers. A metal guard plate 260 is provided on the outer plastic layer of the upper clamshell portion 246. The guard plate 260 provides noise protection for the high impedance signal that transmits from the active capacitor plate 258.

Detailed Description Text (167):
As with the pump 20 of system 10, the active capacitor plate 258 of upper clamshell portion 246 of the pump 120 of the system 100 electrically couples to a capacitance sensing circuit. The guard plate 260 likewise electrically couples to the feedback loop of the capacitance sensing circuit as described above.

Detailed Description Text (170):
In operation, the capacitance sensor 60 operates substantially as described in FIGS. 17A and 17B. The receptacle 172 expands between the portions 246 and 248. A varying distance, .DELTA.d, of the low dielectric displacement fluid between the expanding and contracting receptacle 172 and the portions 246 and 248 may have some effect on the capacitance between the ground plate 262 and the active plate 258. Likewise the surface area, S, defined by the ground and active capacitance plates and the expanding membranes may have some effect on the overall capacitance. Certainly, the changing overall dielectric from the high dielectric dialysate replacing the low dielectric air (or vice versa) affects the overall capacitance between the plates 258 and 262.

Detailed Description Text (172):
As an alternative to the capacitance volume sensor 60 described above, the volume of dialysate fluid flowing through the automated systems 10 and 100 can be determined using other methods, such as through an electronic balance. In such a case, the electronic balance keeps track of the amount of dialysate that is supplied to the system during a priming of the system. The electronic balance also monitors any additional dialysate added to the system during dialysis treatment.

Detailed Description Text (173):
In other alternative embodiments, any of the systems described herein can be sensed using other types of flowmeters or devices employing Boyle's Law, which are known to those of skill in the art. Further, various other types of fluid volume measurement or flowrate devices can be used with the automated systems 10 and 100, such as orifice plates, mass flow meters or other flow measuring devices known to those of skill in the art.

Detailed Description Text (181):
When the pressure reaches a pressure proximity threshold 402, set in software, the software within the controller 30 converts from the previous motion (acceleration, velocity, position) control to an adaptive control. It should therefore be appreciated that the method of controlling pressure within the fluid pump of the present invention is a hybrid type of control method, employing a combination of techniques.

Detailed Description Text (182):
The motion control portion, accented by the acceleration 394 and max velocity 396, represents a period in time when the method of control is forcing the system to

overcome the pressure compliance. Upon reaching the pressure proximity threshold 402, the controller 30 causes the velocity to sharply decelerate at deceleration 404. Deceleration 404 reduces the velocity of the piston 212 and piston head 214 to a velocity 406, which is a velocity that aids in the ability of the adaptive control portion of the pressure control system to achieve a pressure set point 408. That is, without the programmed deceleration 404, the adaptive control portion would have a more difficult (i.e., longer) time controlling the velocity to make the pressure reach or substantially reach the pressure set point 408.

Detailed Description Text (186):
Referring now to FIG. 20, an algorithm 420 for employing the adaptive pressure control during the areas 412 and 414 of the pressure profile 400 is illustrated. In an embodiment, the adaptive control portion of the pressure control method employs a proportional, integral and derivative ("PID") adaptive parameters. In the method, a pressure reading is taken from a pressure sensor which senses the pressure inside the receptacle 172 of the pump chamber 210, and which provides a pressure sensor input 422 to the controller 30, as illustrated by the algorithm 420. Pressure sensor input 422 is sent through a digital filter 424, producing a measured variable 426. The measured variable 426 is compared with a desired variable, i.e., the pressure set point 408 illustrated in FIG. 19, wherein an error 428 is produced between the measured variable 426 and the desired pressure set point 408.

Detailed Description Text (200):
The proximately threshold parameter 488 (illustrated by pressure line 402 in the pressure profile 400 of FIG. 19) also affects overshoot and undershoot. Here, setting the pressure threshold 488 too low may cause undershoot, whereas setting the parameter 488 too high may cause overshoot. The DP/dt parameter 490 is the change in pressure for a given period of time. This parameter seeks to achieve, for example in FIG. 19, a certain slope of the pressure curve 401.

Detailed Description Text (222):
The method 510 uses multiple temperature sensors, such as the sensors 62 illustrated in FIGS. 1 and 2, which sense the temperature at different times within the method 510 and places within system 10,100. One sensor senses the fluid outlet temperature, which feeds back from the heating system 548 to the comparison point 514. Another two temperature sensors sense the temperature of the top plate and the bottom plate and feed back to the temperature limit controller 546, located in software.

Detailed Description Text (229):
Another input signal that varies over time is the input voltage (V.sub.ac). The input voltage V.sub.ac changes over time in a single house or in different locations. Another input signal that changes over time is the measured fluid inlet temperature ("T.sub.in "). Fluid temperature T.sub.in is measured by one of the numerous sensors of the method 510 described above. An input which will like not change over time is the plate heater efficiency ("E"). The heater efficiency E is determined empirically. The heater efficiency E could change depending upon the pressure inside the disposable unit during heating, the material of the disposable unit and the gap tolerance between the top and bottom plate. The heater efficiency E for a particular dialysis device therefore remains substantially constant. As described above, the desired fluid temperature ("T.sub.desired ") may vary, depending on doctor's orders. However, for any given therapy session, T.sub.desired is a constant.

Detailed Description Text (242):
Referring now to FIG. 28, one embodiment of an electrically insulated system 550 of the present invention is illustrated. The system 550 is illustrated schematically, however, certain components of the system 550 are identifiable as components illustrated in the hardware drawings discussed above. For example, the system 550 includes the housing or enclosure 112, illustrated above in FIGS. 3A to 4B, which

includes the base 114 and the lid 116 of the hardware unit 110. The system 550 also includes the heater 16, which in an embodiment includes upper and lower heating plates illustrated in FIG. 3A and discussed in connection with FIGS. 25 to 27. Further, the system 550 includes the display device 40 and temperature sensors 62 illustrated and discussed in connection with FIGS. 1 and 2.

Detailed Description Text (246):
Live part 560 is also electrically isolated from applied part 568, which is maintained at a zero potential. An "applied part" for purposes of the present invention is any part of the system 550 that: (i) comes into physical contact with the patient or operator performing the dialysis treatment; (ii) can be brought into contact with the patient or operator; or (iii) needs to be touched by the patient. For instance, it is possible for the patient to touch the upper or lower plates of the plate heater 16, the temperature sensors 62 and the enclosure or housing 112. The applied part 568 represents schematically the casing or insulation around the temperature sensors 62.

Detailed Description Text (250):
For the heater plate 16 and element 576, at least, the basic and supplemental insulation needs to be electrically insulative but thermally conductive. Polyimides, such as a Kapton.RTM., work very well. In an embodiment, therefore, the B(240) and S(240) layers each include Kapton.RTM. tape or sheet of about 0.3 millimeters thickness. As further illustrated, another layer of basic insulation B (240), rated for 240 VAC, and another layer of supplemental insulation S(240), rated for 240 VAC, are disposed between the temperature sensor 62 and the heater plate 16. Thus the heater plate 16 is completely and doubly insulated from the remainder of the system 550. Alternatively, either of the double layers of insulation can be replaced by a single layer of reinforced insulation.

CLAIMS:

3. The method of claim 1, wherein determining the first heater control output includes measuring and inputting a signal selected from the group consisting of: a measured number of pump stroke intervals, a heater input voltage and a measured fluid temperature.

7. The method of claim 1, wherein determining the first heater control output includes calculating a duty cycle based on a difference between a desired temperature and a measured temperature.

8. The method of claim 1, wherein determining the second heater control output includes: (i) determining a plurality of fuzzy logic membership functions; (ii) converting a difference between a desired temperature and a measure temperature into fuzzy sets based on the membership functions; (iii) applying a plurality of fuzzy logic rules; and (iv) converting an output of the rules to a fuzzy logic based duty cycle.

12. The method of claim 1, which includes the further step of setting a heater temperature limit and preventing the third heater control output from raising a heater temperature above the heater temperature limit.

15. A method of controlling a medical fluid heater comprising the steps of: determining a first heater control output using a first mathematical relationship between a number of heater inputs and updating the first output at a first frequency; determining a second heater control output using a second mathematical relationship between a number of heater inputs and updating the second output at a second frequency, wherein the second mathematical relationship includes a measured fluid temperature feedback at the second frequency; and determining a third heater control output based on the first and second outputs and using the third heater control output to control the heater.

18. The method of claim 15, wherein determining the second heater control output includes inputting a difference between a desired fluid temperature and an actual temperature, at the second frequency, into the second mathematical relationship.

20. A method of controlling a medical fluid heater comprising the steps of: determining a first heater duty cycle based on at least one input signal selected from the group consisting of: a measured number of pump stroke intervals, a heater input voltage and a measured fluid temperature; determining a second heater duty cycle by: (i) determining a plurality of fuzzy logic membership functions; (ii) converting a difference between a desired temperature and a measure temperature into fuzzy sets based on the membership functions; (iii) applying a plurality of fuzzy logic rules; and (iv) converting an output of the rules to the second duty cycle; and determining a third heater duty cycle based on the first and second heater duty cycles and using the third heater duty cycle to control the heater.

Previous Doc Next Doc Go to Doc#

Hopping, Peter Lutz FL US

US-CL-CURRENT: 210/739; 210/143, 210/175, 210/258, 210/742

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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L5: Entry 5 of 6 File: PGPB Nov 27, 2003

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TITLE: Electrically insulated automated dialysis system

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INVENTOR-INFORMATION:

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☐ 6. Document ID: US 6869538 B2

L5: Entry 6 of 6 File: USPT Mar 22, 2005

US-PAT-NO: 6869538
DOCUMENT-IDENTIFIER: US 6869538 B2

TITLE: Method and apparatus for controlling a medical fluid heater

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw De

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Terms	Documents
(single adj house) and heat$.clm. and temperature.clm. and (prox$ neare3 sens$)	6

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IDS Information

Content	Mailroom Date	Entry Number	IDS Review	Last Modified	Reviewer
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